Quarterly Analytic Review

http://www.ott.doe.gov/facts/program_reviews.htm

July 26, 2001

Philip Patterson

Office of Transportation Technologies

Alicia Birky

Jim Moore

Tatyana Gurikova

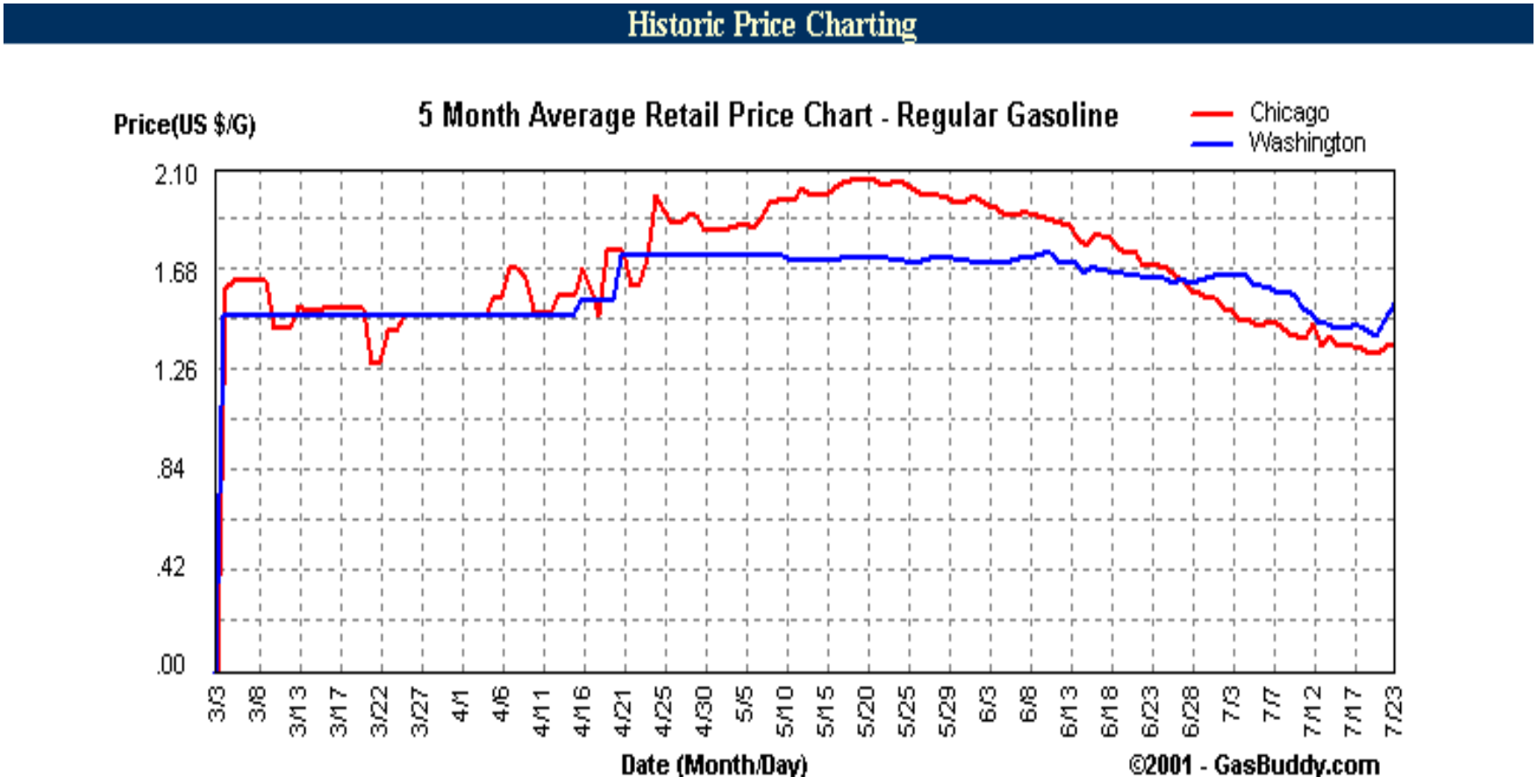
Margaret Singh

(OTT Laboratory Analytic Team)

Agenda

- NG Pathway Analysis (Preliminary)
- Phase 2 of the 2050 Analysis
- CAFE Analysis
- Quality Metrics FY'03 Issues
- Gasoline Price Impacts
- Survey Data
- Web Site Information

Chicago Gasoline Prices
Compared to Chicago (5 months)



Summary of U.S. Petroleum Balance, 2000

- Total Petroleum Products Supplied: 19.5
- Net Imports: 10.1
- Domestic Supply 9.4
  - **Crude Oil Production 5.8**
  - **Natural Gas Liquids 2.1**
  - **Other (gain, blends, etc.) 1.5**

Natural Gas in Transportation Pathway Analysis
(Preliminary)

- **Is there "enough" natural gas in the U.S. or North America to sustain natural gas use in transportation?**
- **Issues addressed:**
  - **U.S. and NA natural gas resources**
  - **Potential for NG imports**
  - **Demand for NG from other sectors (especially electric utilities)**
  - **Demand for NG from transportation (four cases)**

Mexico Not Likely to Be Energy Supplier for U.S.

- EIA projects that Mexico will consume all its oil production by 2020
- Potential Gas Committee and Gas Technology Institute project that Mexico will be a net natural gas importer for the foreseeable future

Related Long-Term Studies WBCSD

- **Mobility 2000 report not done yet. Missed March and May deadlines. Due end of July. September the target for the Challenge Report.**
- **Six of ten dialogues around the world have been conducted.**
- **Two new companies have joined at $1 million sponsorship: Honda and Renault.**
- **Want eleven action teams (each headed by one of the sponsor companies)**
- **No longer interested in DOE dollar support, but would like in-kind assistance.**

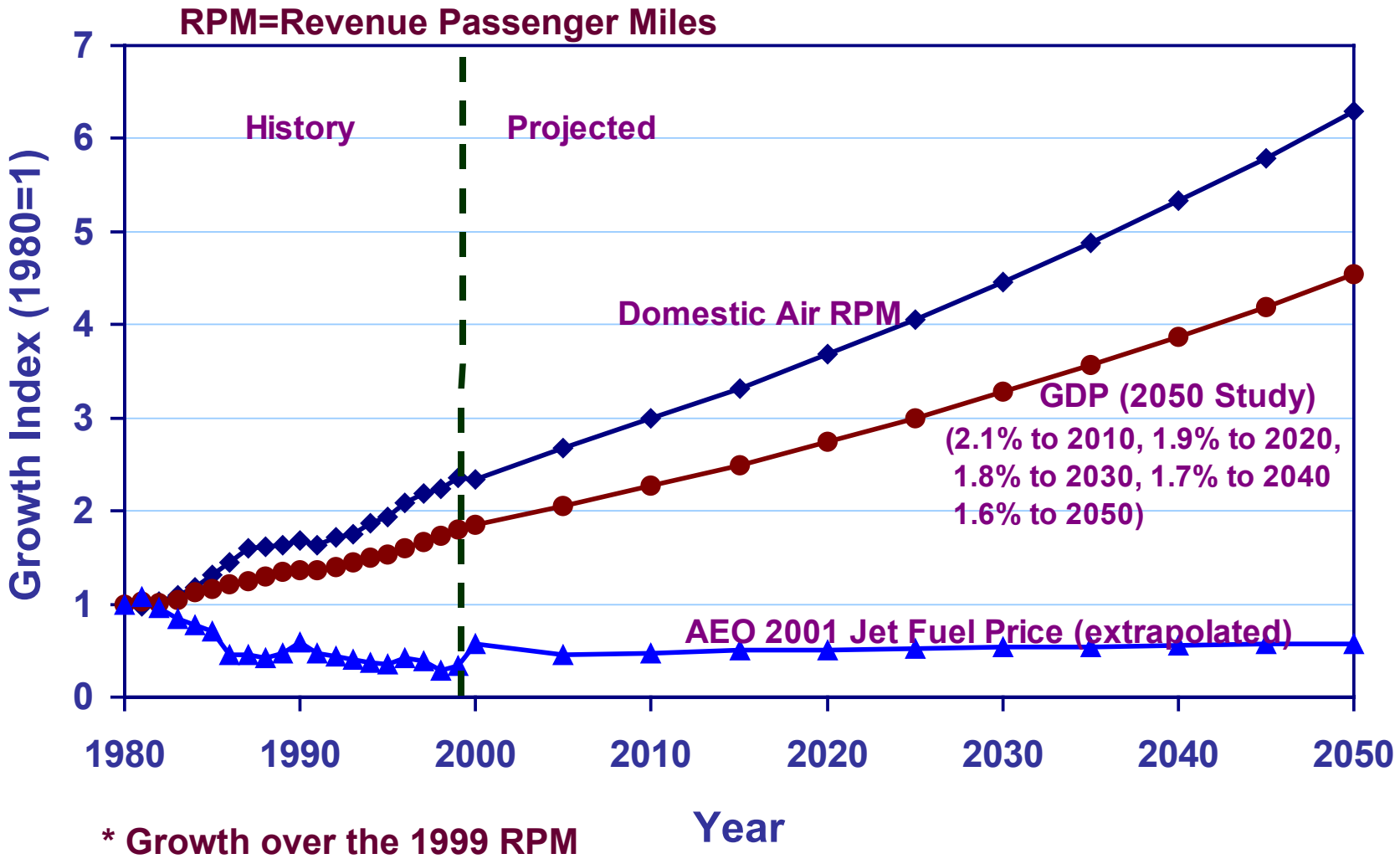
WBCSD Project

- WBCSD Presentation (31 minutes) by Lewis Dale of GM on EVWorld (http://www.evworld.com/databases/storybuilder.cfm?storyid=207)
- Should we brief David Garman on this project?

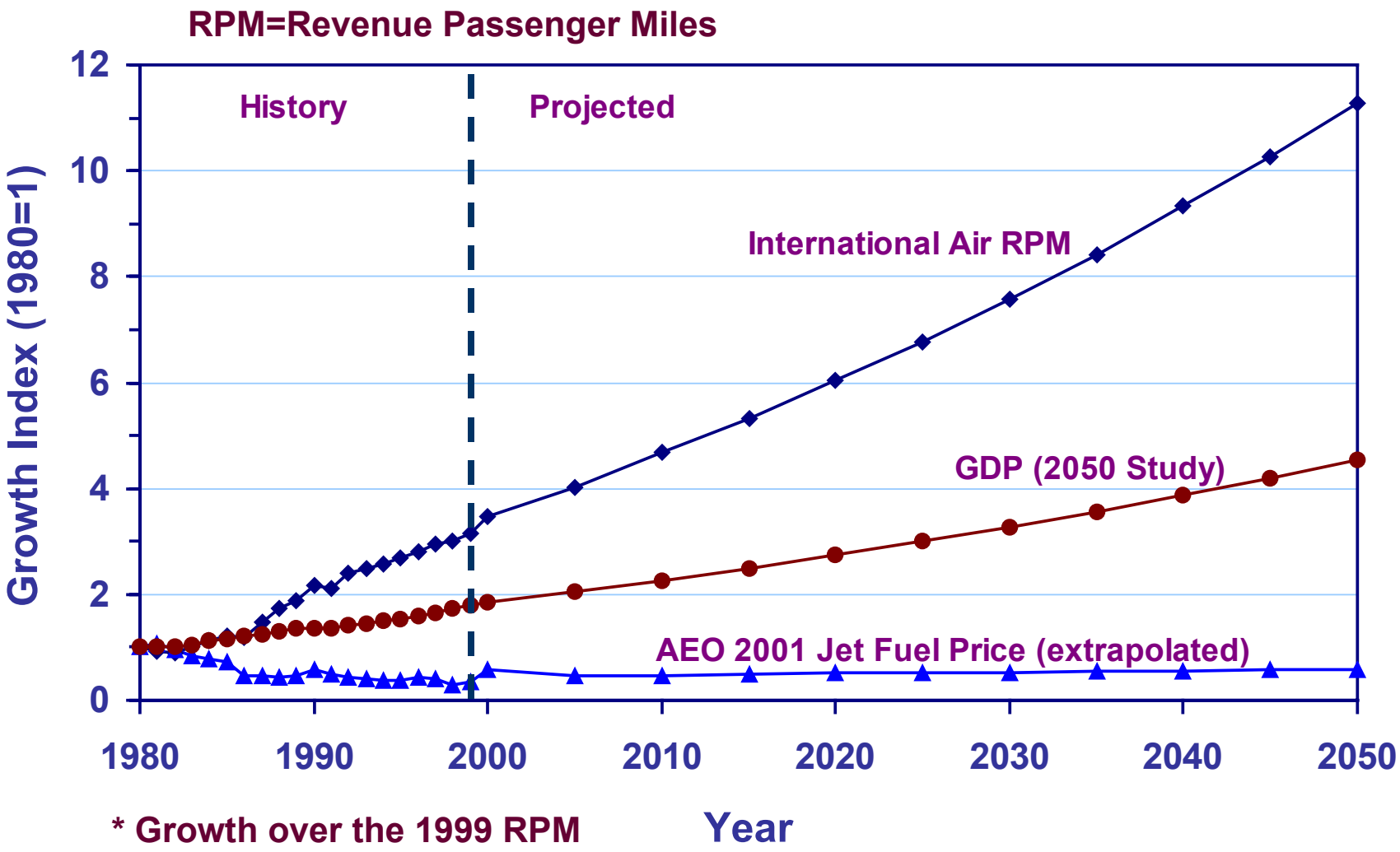
Other Studies

- MARKAL Model results will be available later this year. Phillip Tseng (EERE) is a major player in this project.
- Battelle “Global Energy Technology Strategy”, 2001 (Jae Edmonds, et al): half way through a six year program.

A 170%* Domestic Air RPM Rise Is Seen With Growing GDP and Stable Fuel Price



International Air RPM Rise 360%* Under the Same GDP and Fuel Price Scenario



Vehicle Technology Cost Elements

- **Life cycle costs: purchase, energy, maintenance, and operating costs**
- **Technologies: Conventional ICE**
  Advanced Diesel
  CNG
  Electric
  Hybrid
  Fuel Cell (Hydrogen)
- **Fuel prices will be based on energy model outputs**
- **Cost estimates will vary by scenario**

Vehicle Technology Costs

	TECHNOLOGY COSTS FOR FUEL CELL VEHICLE (SHOWN AS A RATIO OF FUEL CELL COST TO CONVENTIONAL ICE COST)							
Cost Component	**DTI (1998)**	**Ogden (1998)**	**Litman (1999)**	**ANL (2000)**	**Weiss (2000)**	**Contadini (2001)**	**Range of Values**	**Mean Value**
Initial Cost ($)	1.11	0.91	1.20	1.40	1.23	1.05	0.91 to 1.40	1.15
Vehicle Life (Year)	-	-	-	1.00	1.00	1.14	1.00 to 1.14	1.05
Annual Usage (Mile)	-	-	-	1.00	1.00	1.00	1.00	1.00
Fuel Economy (mpg)	2.20	2.43	-	3.00	2.18	2.50	2.18 to 3.00	2.46
Fuel Cost ($ per equiv.gal.gas.)	-	-	-	0.50	0.71	1.00	0.50 to 1.00	0.74
Annual Maintenance Cost ($)	-	-	-	1.40	-	0.84	0.84 to 1.40	1.12
Annual Operating Cost ($)	-	-	-	0.80	1.02	-	0.80 to 1.02	0.91

Vehicle Technology Costs

TECHNOLOGY COSTS FOR FUEL CELL VEHICLE								
Cost Component	**DTI (1998)**	**Ogden (1998)**	**Litman (1999)**	**ANL (2000)**	**Weiss (2000)**	**Contadini (2001)**	**Range of Values**	**Mean Value**
Initial Cost ($)	20,000	19,999	24,570	28,000	22,100	20,000	19,999 to 28,000	22,445
Vehicle Life (Year)	-	-	-	13.0	15.0	16.0	13.0 to 16.0	14.7
Annual Usage (Mile)	-	-	-	10,500	12,427	12,000	10,500 to 12,427	11,642
Fuel Economy (mpg)	66.0	106.0	-	84.4	94.1	75.0	66.0 to 106.0	85.1
Fuel Cost ($ per equiv.gal.gas.)	-	-	-	1.25	0.69	1.30	0.69 to 1.30	1.08
Annual Maintenance Cost ($)	-	-	-	1,400	-	434	434 to 1,400	917
Annual Operating Cost ($)	-	-	-	1,556	671	-	671 to 1,556	1,114

All costs will be converted to a common year's dollar value

Ethanol Production Costs

	Near Term	Near Term Best of Industry	2005	2010	2015	Adv. Tech	Best Para-meter
Ethanol Yield, gal/dry metric ton	68	76	81	94	99	90% theor.	97% theor.
Production, Million gal/yr	52.2	58.8	62.2	82.2	87.5	**249.4**	349.7
Total Investment, Million 1995$	233.8	205.3	169.4	156.1	159.3	**268.4**	221.1
Feedstock cost, 1995$/dry ton	$25	$25	$25	$25	$25	**$38.6**	$34
Feedstock cost, 1995$/gal	0.33				0.22	**0.37**	0.29
Production Cost, 1995 $/gal	1.44	1.16	0.94	0.82	0.76	**0.53**	0.34

Source: Lynd, Elander, and Wyman, 1996, advanced technology and best parameter cases; Wooley, Ruth, Sheehan, Ibsen, Majdeski, and Galvez, 1999, all other cases.

Potential Ethanol Availability

	Feedstock Cost, $/dt		
	$25	**$35**	**$50**
Feedstock Available, 10^6 dt	64	210	511
Ethanol Potential, Quads			
Near Term	0.37	1.21	2.94
Near Term, BOI	0.41	1.35	3.28
2005	0.44	1.44	3.50
2010	0.51	1.67	4.06
2015	0.54	1.76	4.28
Advanced Tech	-	-	-
Best Parameter	-	-	-

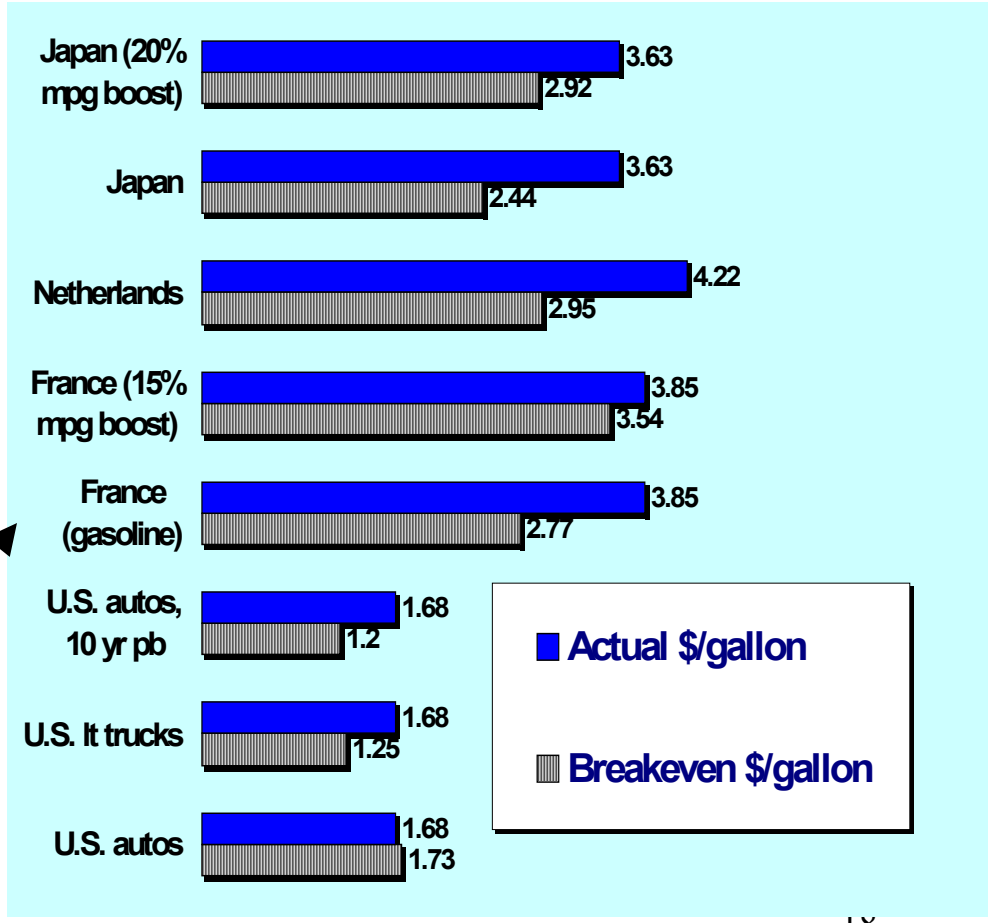
Examination and Evaluation of Japanese and European Fuel Economy Initiatives

- **Japanese weight class standards: 22.8% fleetwide improvement**
- **European Union Voluntary Commitment: 33% improvement**
- **Key issues:**
  - **Japanese standards allow limited averaging across weight classes….could be big problem for U.S., European imports**
  - **Japanese 10.15 cycle, mild emission standards yield big gains from Gasoline Direct Injection engines, Variable Valve Timing and Lift, hybrid drivetrains, idle stop**
  - **Japanese standards may create incentives for weight gain**
  - **EU: enforcement is undefined, manufacturers' targets not clear; diesel role is crucial**

Implications for U.S.

- Tougher U.S. emission standards, faster test cycle yield reduced benefits from several key technologies, e.g. GDI
- Cost/benefit of key technologies not quite as good: lower gasoline prices somewhat offset by higher mileage and lower vehicle taxes in U.S.
- Example: GDI engines fare better in Japan and Europe

Actual vs. Breakeven Prices for GDI Engines in Various Markets



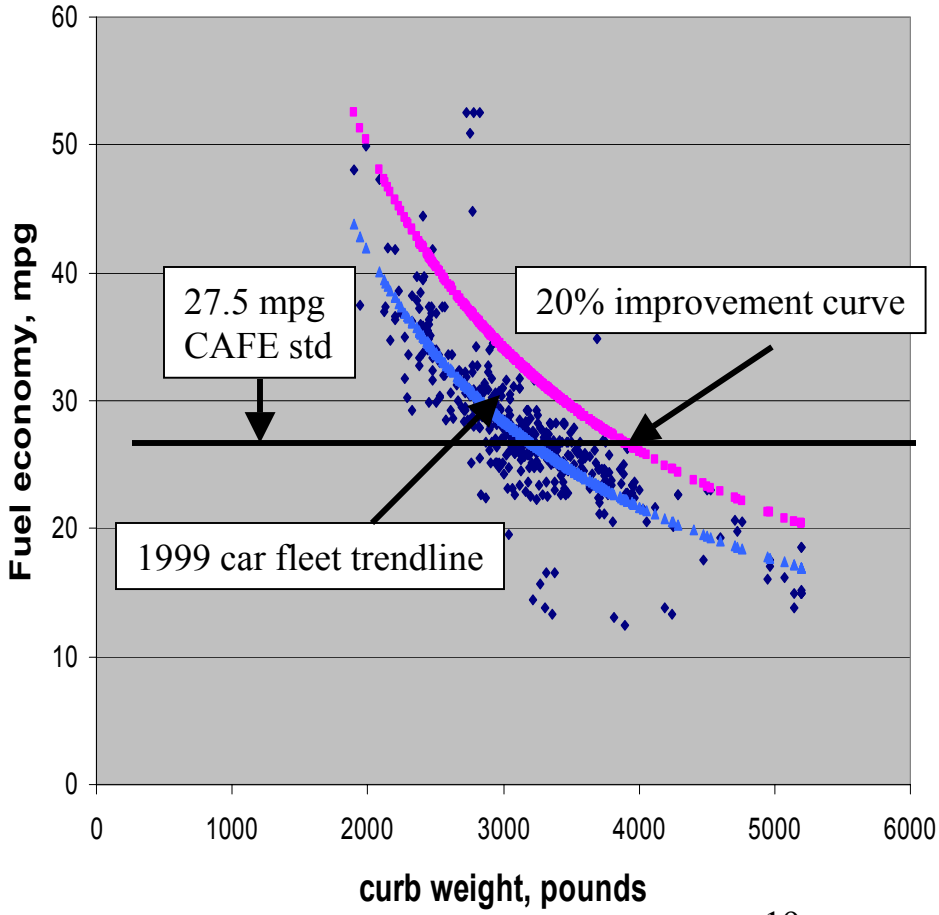
Examination of alternative structures for a voluntary fuel economy standard

- **Focus on metrics of a standard**
- **Examined curb weight, interior volume, length x width, wheelbase x width**
- **Weight is well correlated with fuel economy**
- **Figure to the right: one way to structure a weight standard: the 20% improvement std formula is:**

MPG target = 1.2*23220*(wt)$^{-.8368}$

- **Note: this type of standard actually has small positive incentive for weight *gain***

One Concept for a Weight-Based Standard



The objective of this analysis is to determine which forms and levels of standards are most conducive to voluntary cooperation.

- Reasonably Achievable
  - within technological potential
  - likely to be accepted by customers
  - produce meaningful societal benefits
- Equitable
  - equal burden
  - competitively neutral

The strategy is to estimate the costs, by manufacturer, of various potential standards.

- Levels:
  - 20% (33.0 cars, 24.8 light trucks)
  - 33% (36.6 cars, 27.5 light trucks)
- Timing: 2010-2015
- Forms of standards:
  - Constraint structure: Industry-wide (tradable), Manufacturer, Vehicle Type, Origin.
  - Metric: CAFE, UPI, Weight-based
- Constant MY 2000 product mix

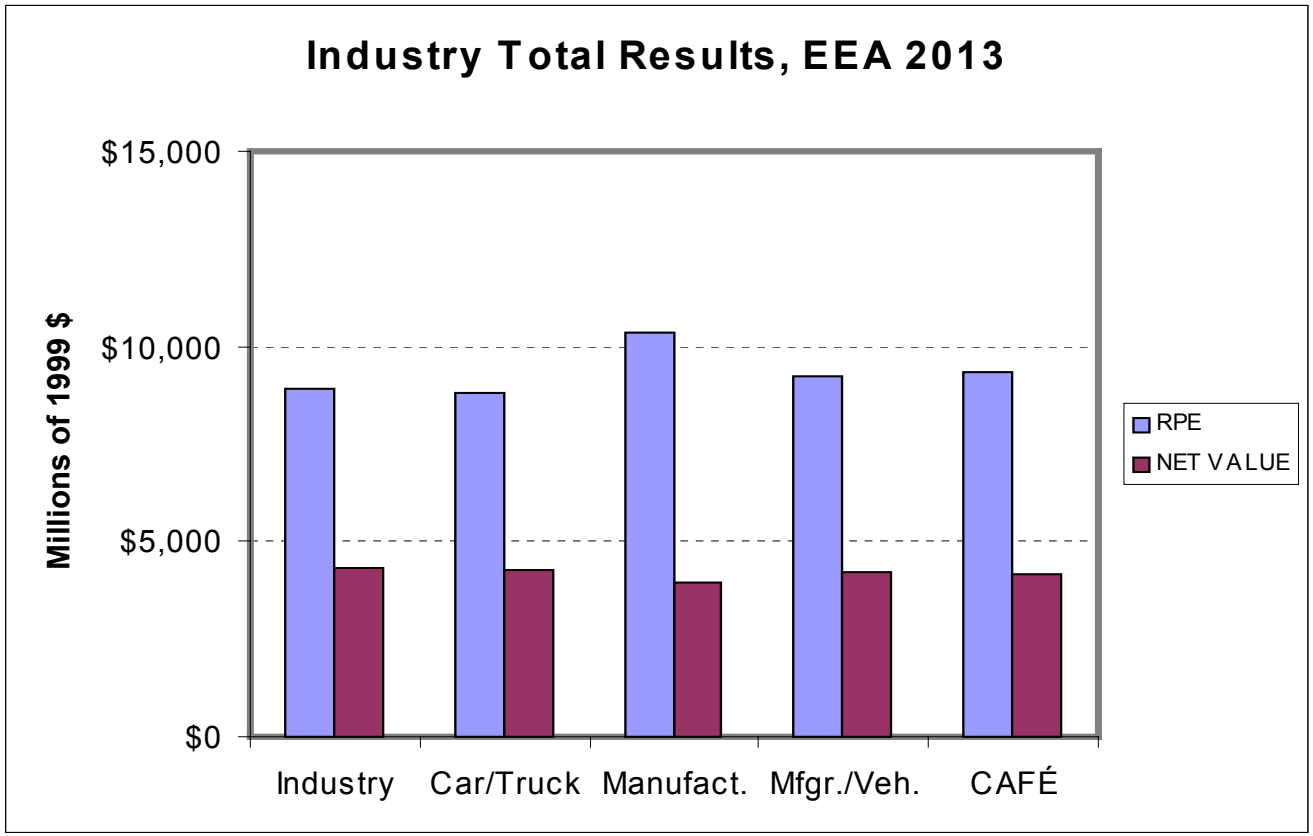
Two metrics and two 2013 fuel economy levels have been analyzed to date.

- AFES, 20% Cars: 33.6 Lt. Trks.: 25.9
- AFES, 33% Cars: 37.4 Lt. Trks.: 28.6
- UPI, 20% Cars: 34.6 Lt. Trks.: 26.4
- UPI, 33% Cars: 38.5 Lt. Trks.: 29.2
- Based on industry-wide AFES, manufacturer UPI.

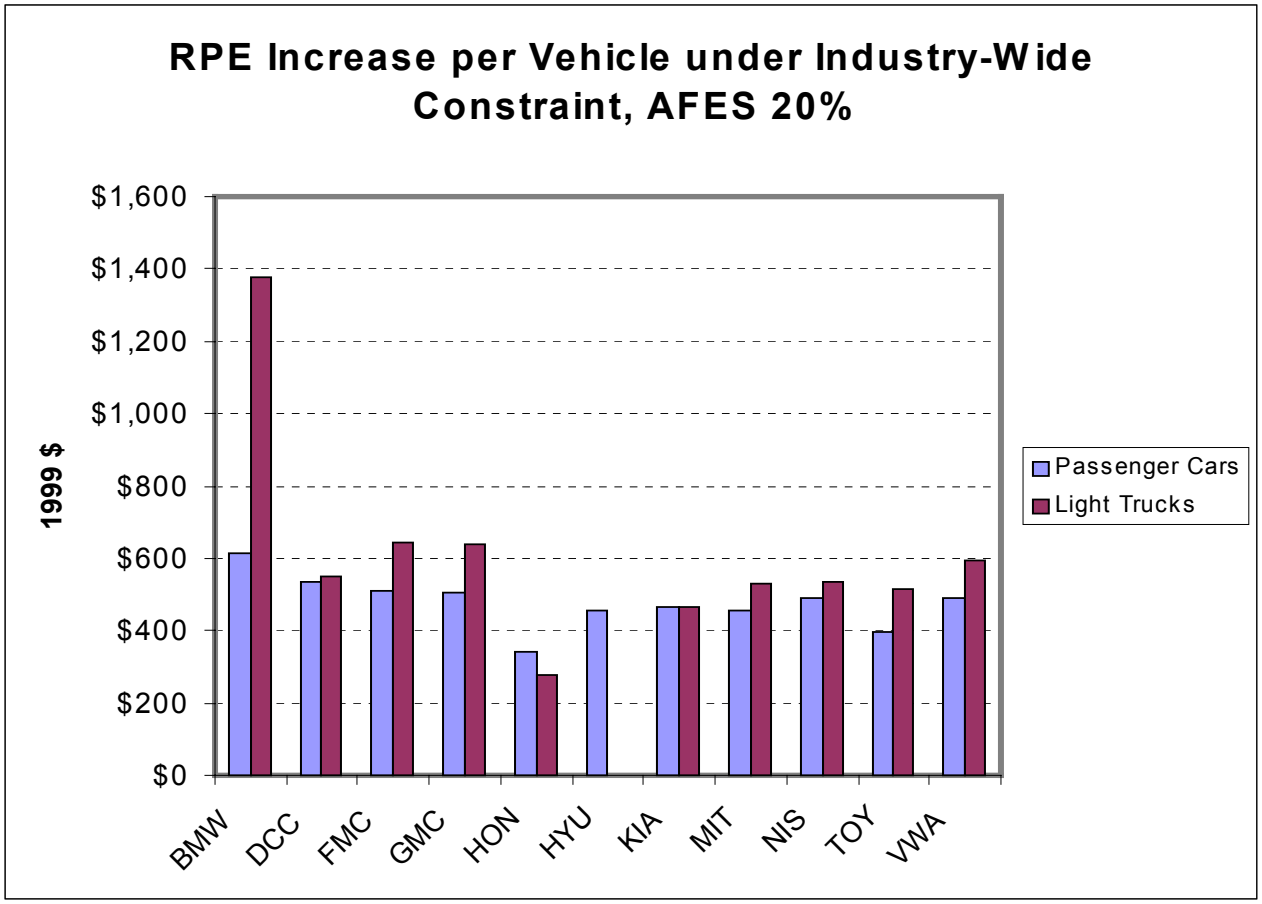
Key assumptions:

- $1.35/gal. (EIA, 2015)
- 12% discount rate, 4%/yr. decline in VMT
- 15,600 miles/year, new
- 14 year lifetime
- weight elasticity of MPG: $\beta = -0.54$
- Hp/wt elasticity of MPG: $\alpha = -0.25$
- Safety & emissions MPG penalty: 3.5%
- time period: 2010-2015

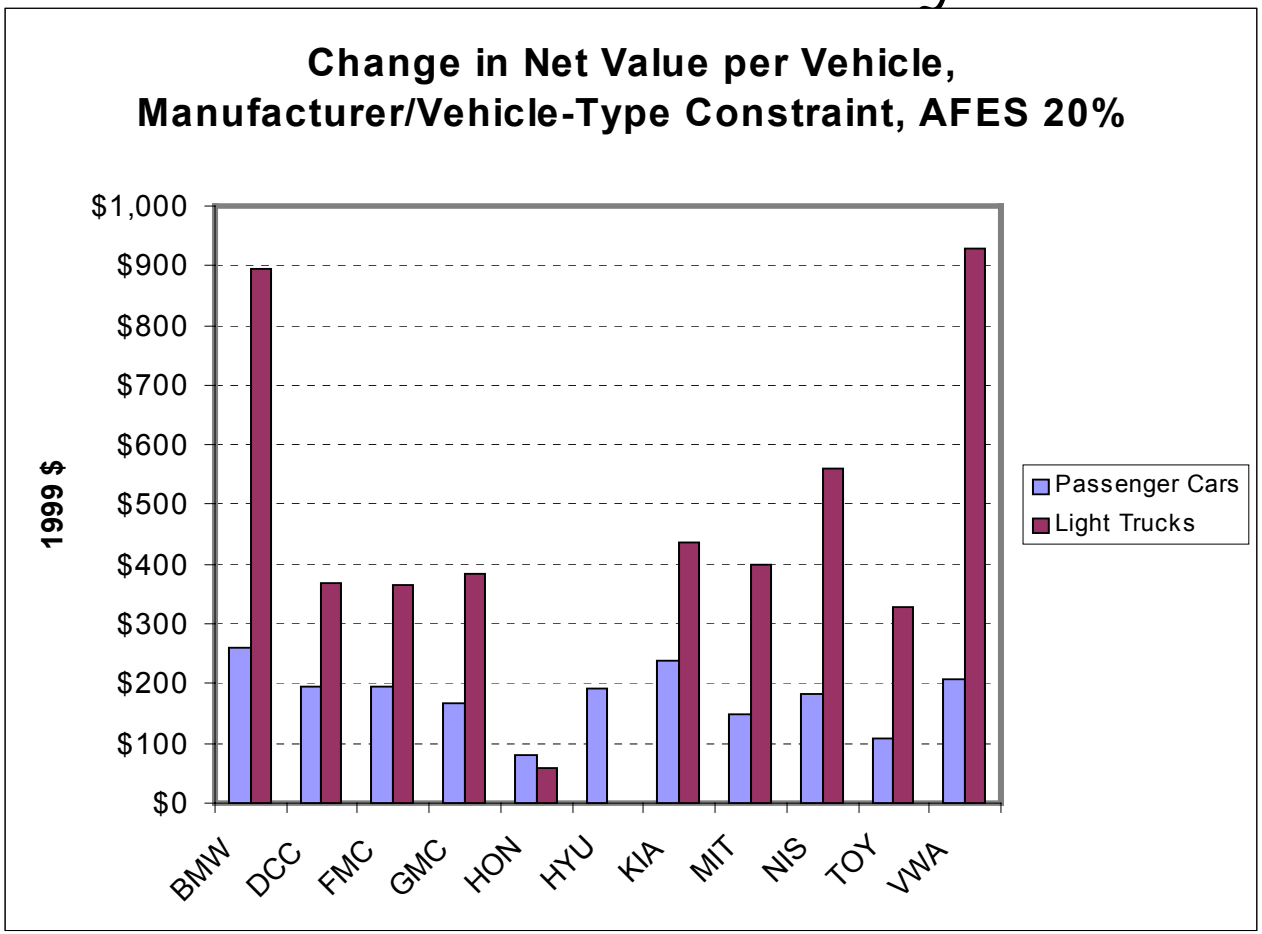
For 20% increase, using EEA 2013, total RPE increase is about $10B, net value increase is about $4B.



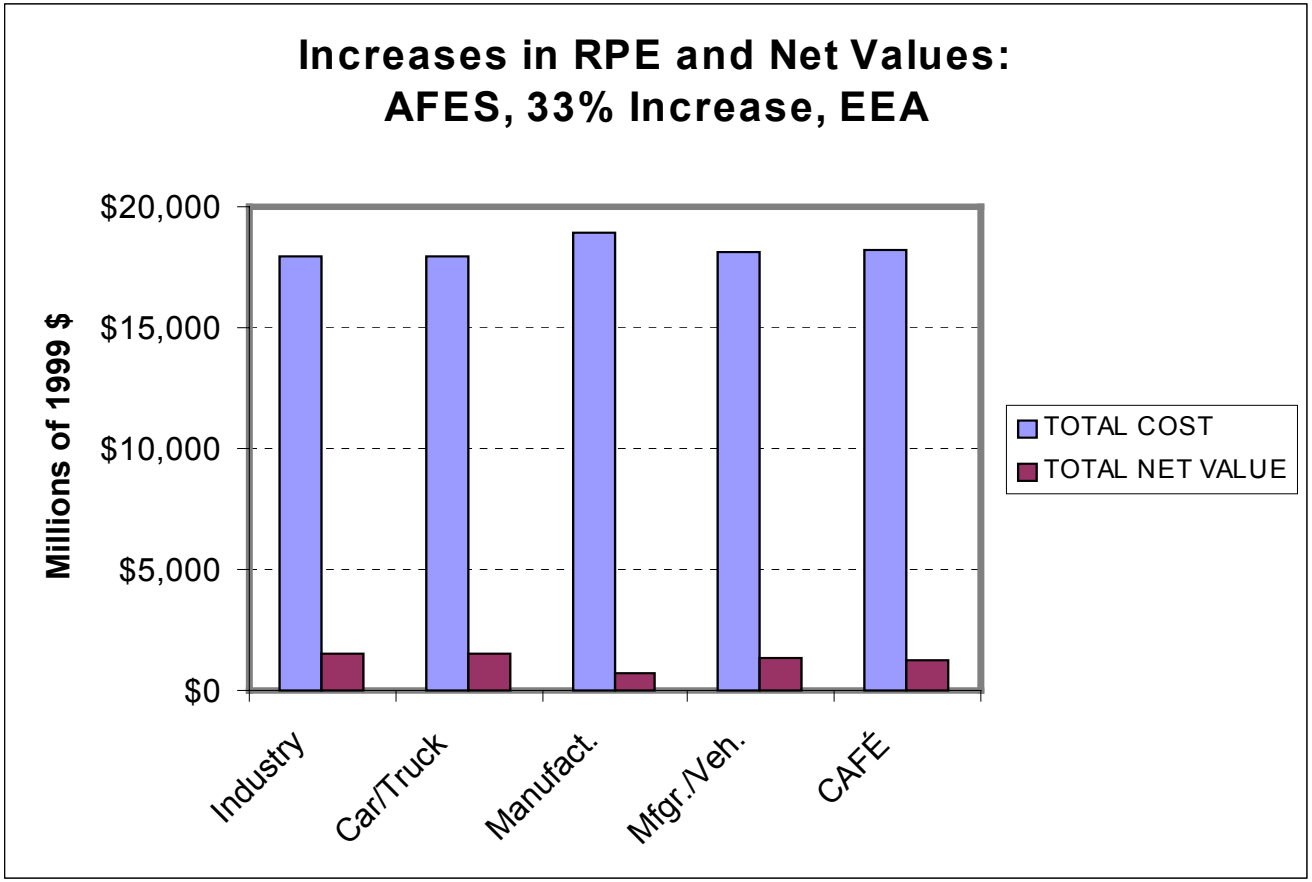
Under an Industry-wide constraint (tradable credits) RPE increases are similar across manufacturers.



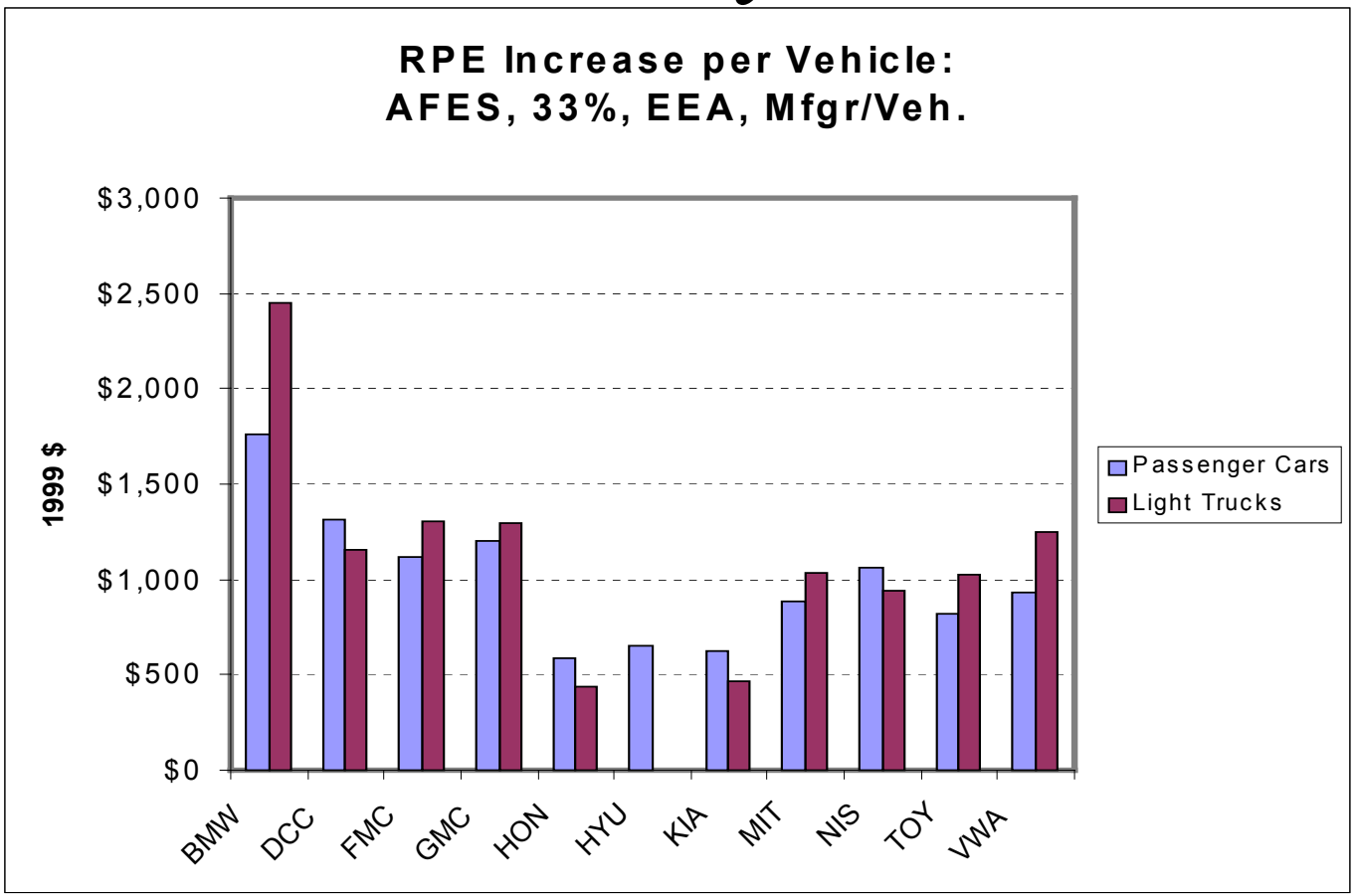
Net values increase more for truck than car buyers.



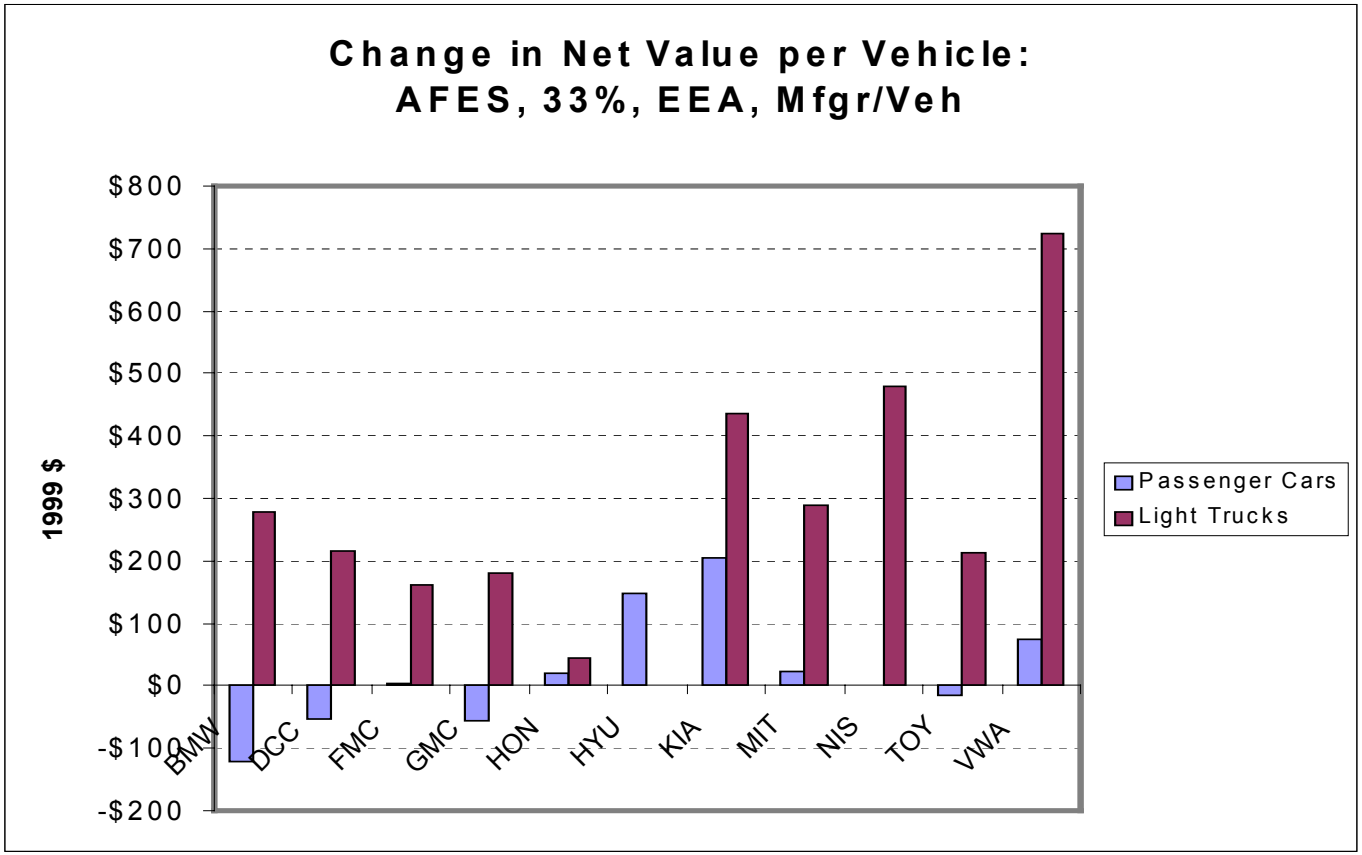
The costs of the 33% increase are higher, and net values are lower.



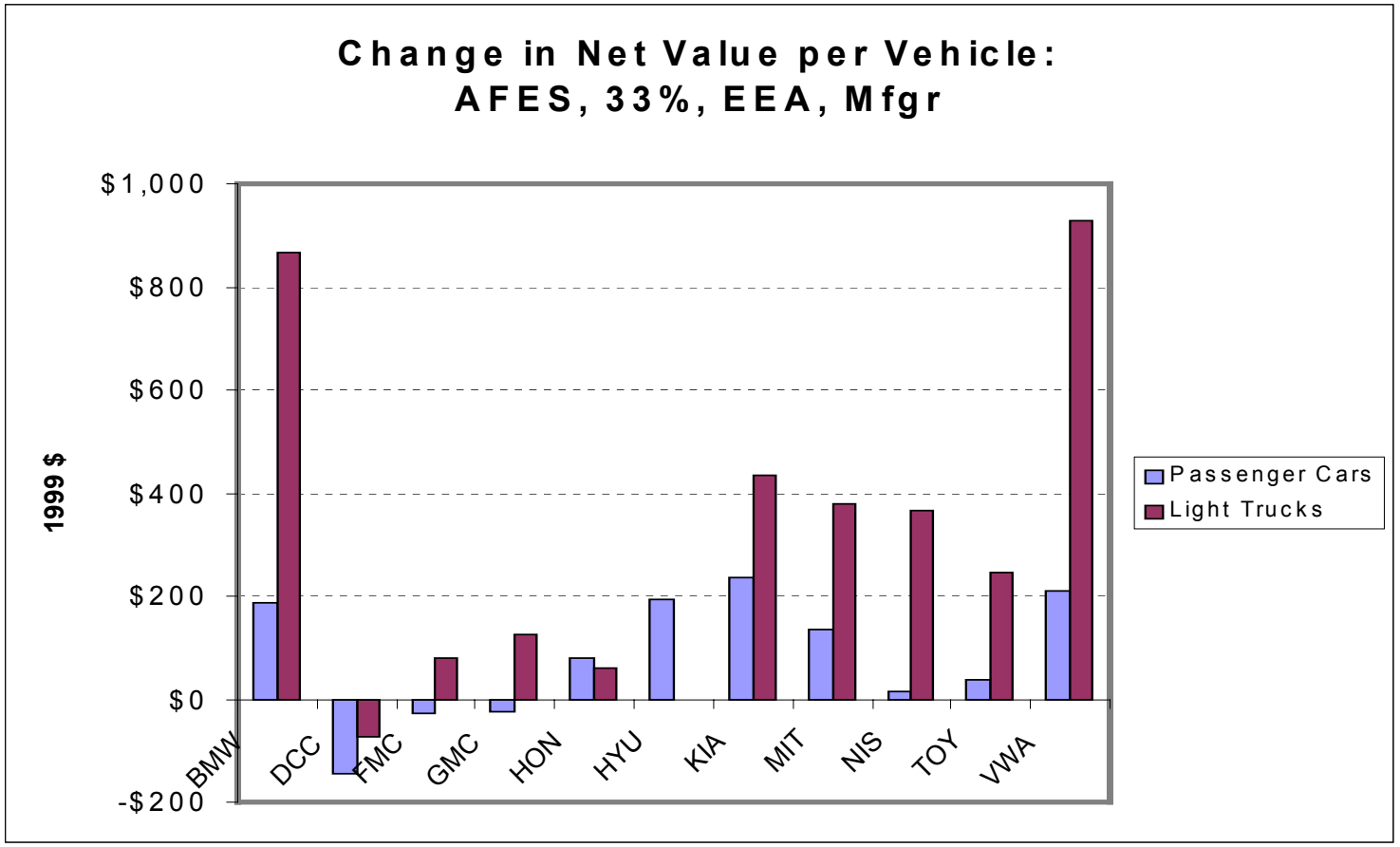
At the 33% level, the big three's RPEs increase by over $1,000.



But 33% is past the private optimum, especially for cars.



The unified car-truck manufacturer standard hurts D-C, Ford, GM.



Of course, the results must be interpreted with care.

- **All manufacturers assumed to have full access to all technologies.**
- **Analysis at high level of generality.**
- **Conditional on key assumptions.**
- **Sierra, EEA curves limited to current technology.**
- **Constant vehicle attributes assumed.**
- **2000 MY baseline unchanged.**

Drilling in Detroit (UCS):
June 2001

- Suggests 40 mpg car/light truck CAFE by 2012 and 55 mpg by 2020
- 55 mpg needs hybrid technology
- Maintain or improve crash safety
- No diesel engines used
- In 18 years, oil saved would be four times the oil available from ANWR
- 103,700 net job increase in 2020

Light Vehicle MPG % Improvements

	Total	Small Car	Large Car	Minivan	SUV	Pickup
OTT: QM'02						
2000	24.38	30.1	25.89	25.03	18.1	20.48
2020	34.46	46.77	39.54	33.76	27.44	27.79
% Change	**41**	**55**	**53**	**35**	**52**	**36**
Drilling in Detroit						
Evolutionary: Stage 1	**52**	**42**	**56**	**55**	**70**	**37**
Evolutionary: Stage 2	**74**	**57**	**75**	**85**	**98**	**61**
Hybrid: Stage 1	**103**	**83**	**101**	**117**	**133**	**86**
Hybrid: Stage 2	**128**	**106**	**126**	**145**	**163**	**110**

Strategies for Reducing Oil Imports (ACEEE): April 2001

- Increase car CAFE to 44 mpg and light truck CAFE to 33 mpg by 2012
- Beyond 2012, increase CAFE 3% per year (car and light truck CAFE would be 50 mpg by 2020 and 64 mpg by 2030)
- Oil savings by 2020 would be 4.75 mbpd, 8 to 16 times greater than ANWR potential

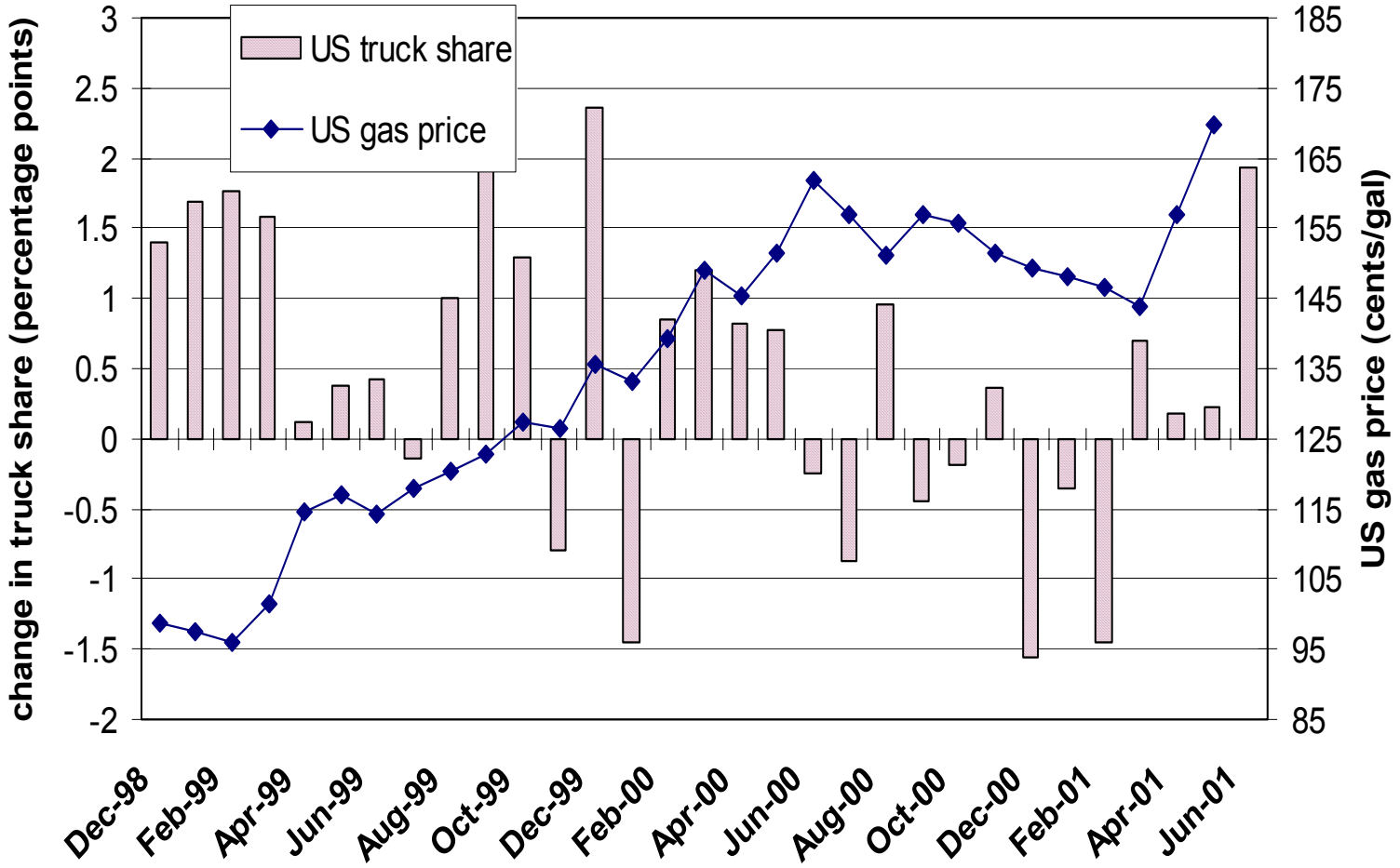
"On the Road in 2020": MIT
October 2000

- **Baseline conventional car gets 43 mpg using gasoline in 2020**
- **Advanced gasoline = 49 mpg; diesel = 56mpg**
- **Advanced HEV gasoline = 71; diesel = 82.5**
- **Advanced Fuel Cell gasoline = 42.5; methanol = 57; hydrogen = 94**
- **Dismisses biofuels as less than 1% of fuel by 2020**
- **Only electricity and hydrogen listed as low-carbon potential, if from non-fossil energy**

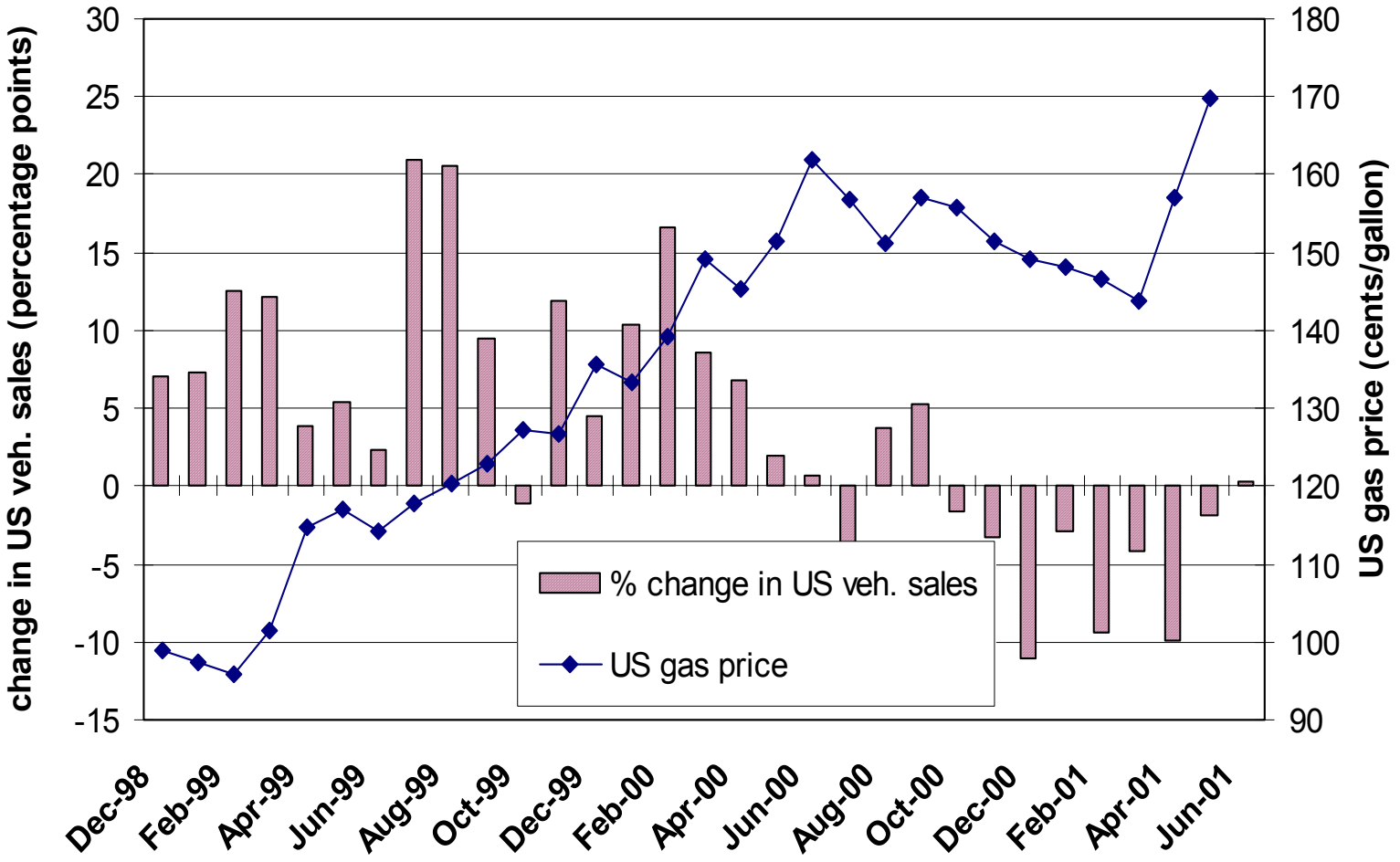
Quality Metrics FY'03 Issues

- Change the two HEV options (2X and 3X)?
- Allow LT mpg % gains to equal that for cars?
- Continually reduce cost delta for advanced vehicles over time?
- Introduce both CIDI and SIDI?
- How to better handle benefit estimates for Technology Assistance?

Change in US light-duty truck share from previous year



Change in US light-duty vehicle sales from previous year

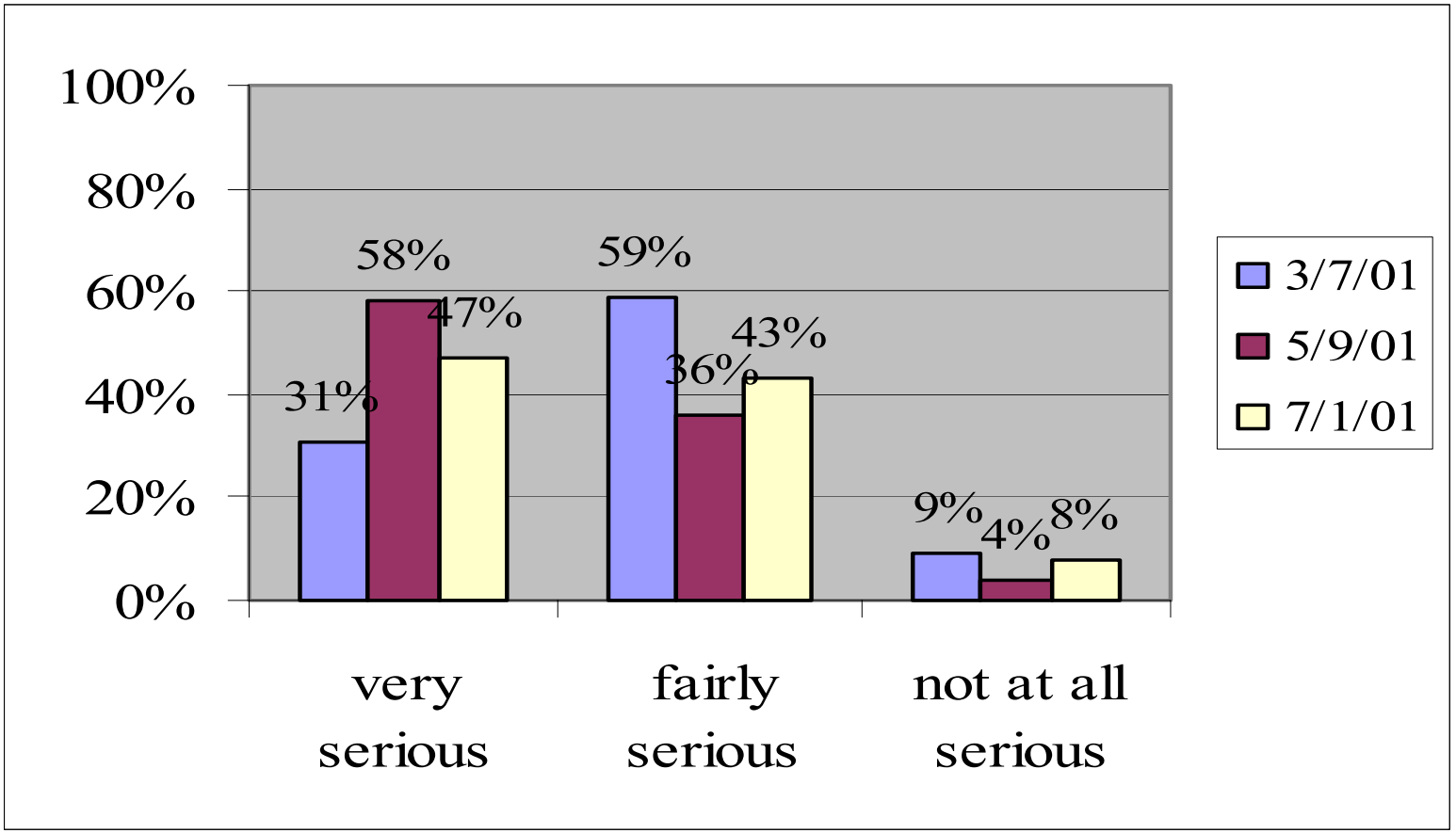


Transportation Energy Survey Data Book 1.0

- **Prepared by Tatyana Gurikova**
- **At website: http://www.ott.doe.gov/facts/papers.htm**
- **Surveys we conduct via Opinion Research Corporation International**
- **Other surveys of interest**
- **Table 3.1.5 shows the average number of years vehicle buyers plan to keep their vehicle is 6.9 years**

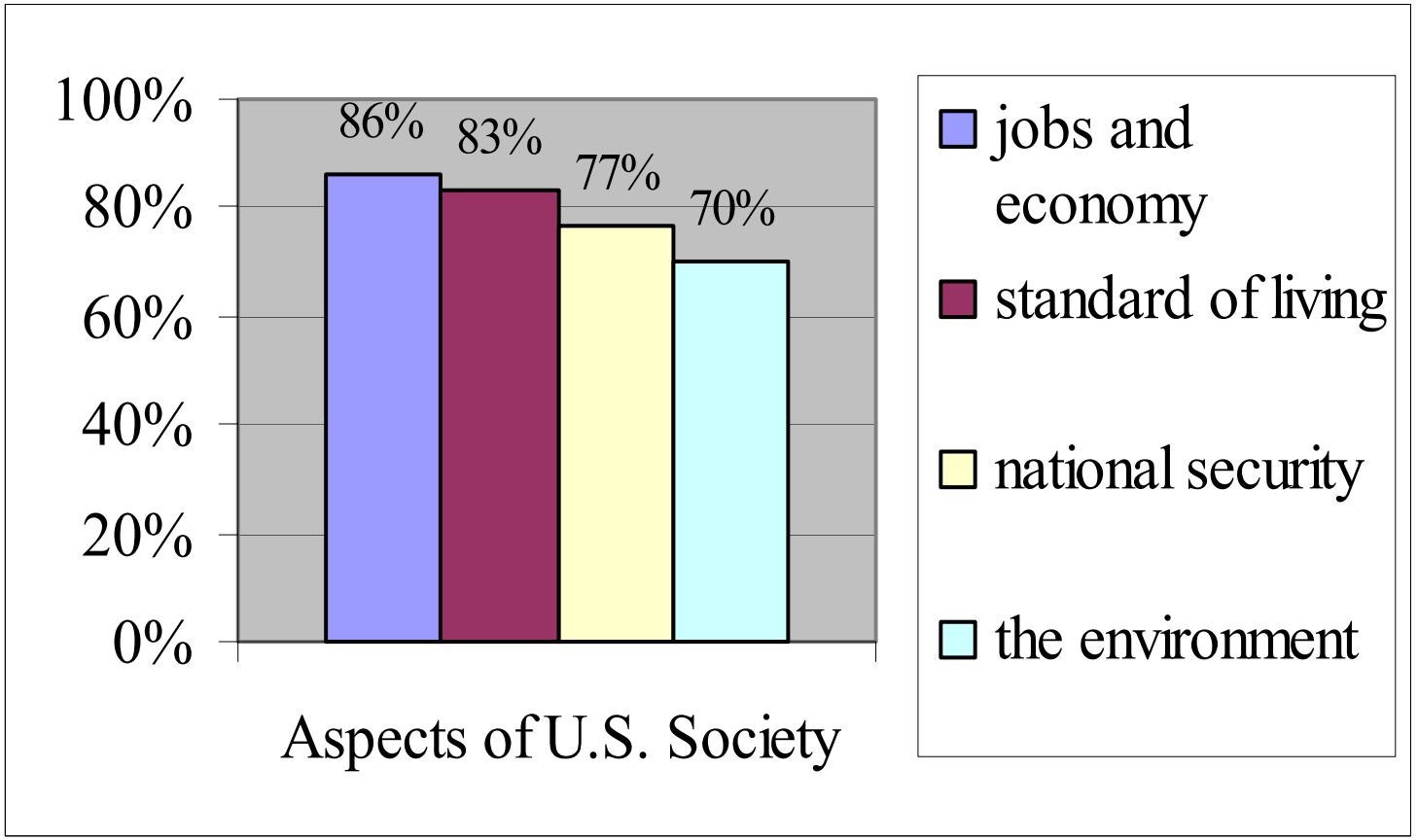
Public Assessment of the Energy Situation in the United States

(Gallup Poll, July 1, May 9, March 7, 2001)



Dependence on Foreign Oil Is the Most Serious Threat To

(Research/ Strategy/ Management, Inc., Sept 22 – 28, 1998, N= 1,003)



Things Americans Favor to Deal with the Energy Situation

(Gallup Poll, May 7 – 9, 2001, N = 1,005)

- Investments in new sources of energy such as solar, wind and fuel cells - **91%**
- Mandates on more energy efficient appliances such as air conditioning, clothes dryers, water heaters - **87%**
- More energy efficient new buildings - **86%**
- Mandates on more energy efficient cars - **85%**
- Investments in new power generating plants - **83%**
- Federal Government partnership with auto industry working towards energy efficient cars - **76%**

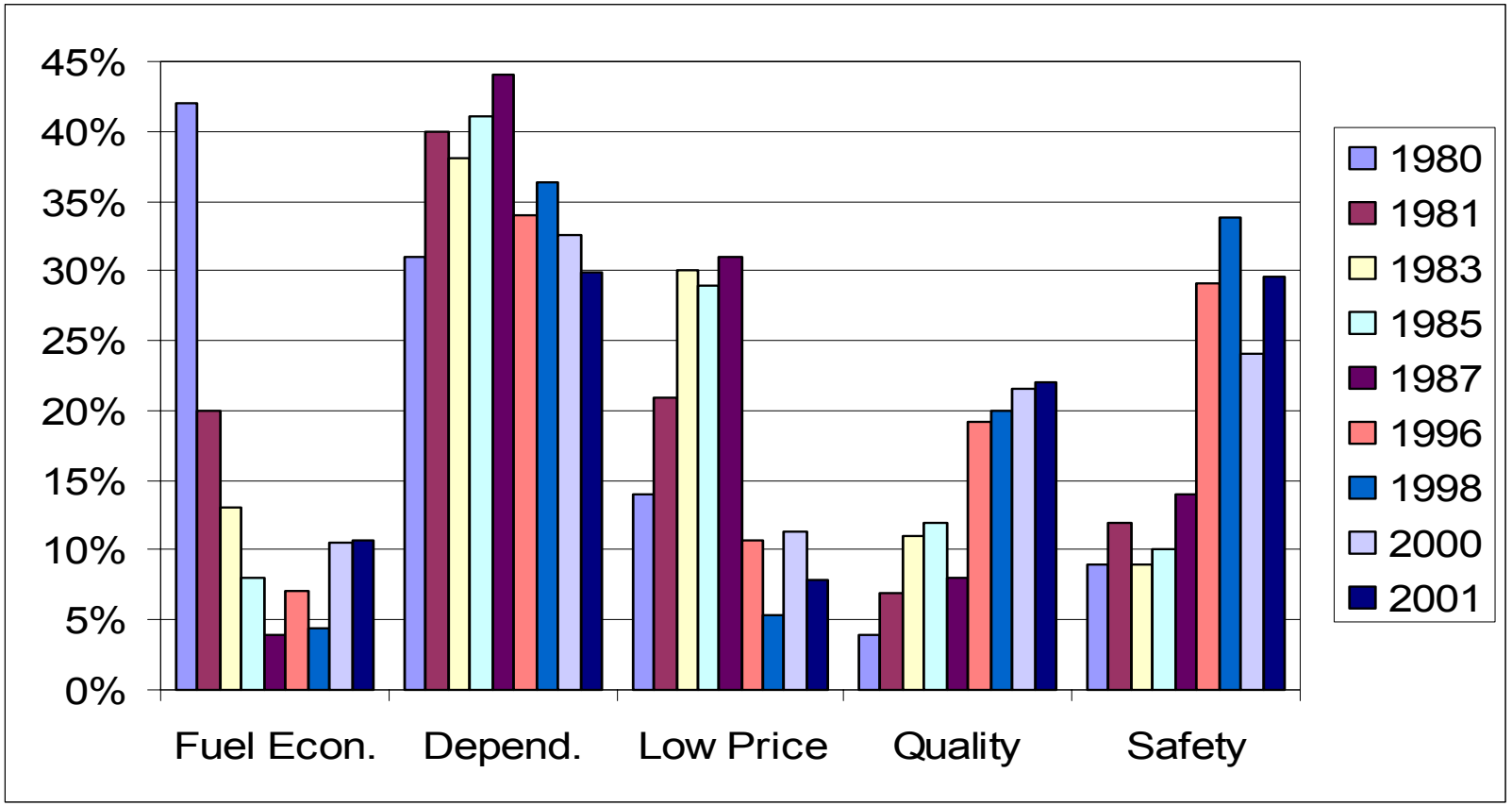
Things Americans Favor to Deal with the Energy Situation

(NBC News/ Wall Street Journal, June 23 – 25, N= 806)

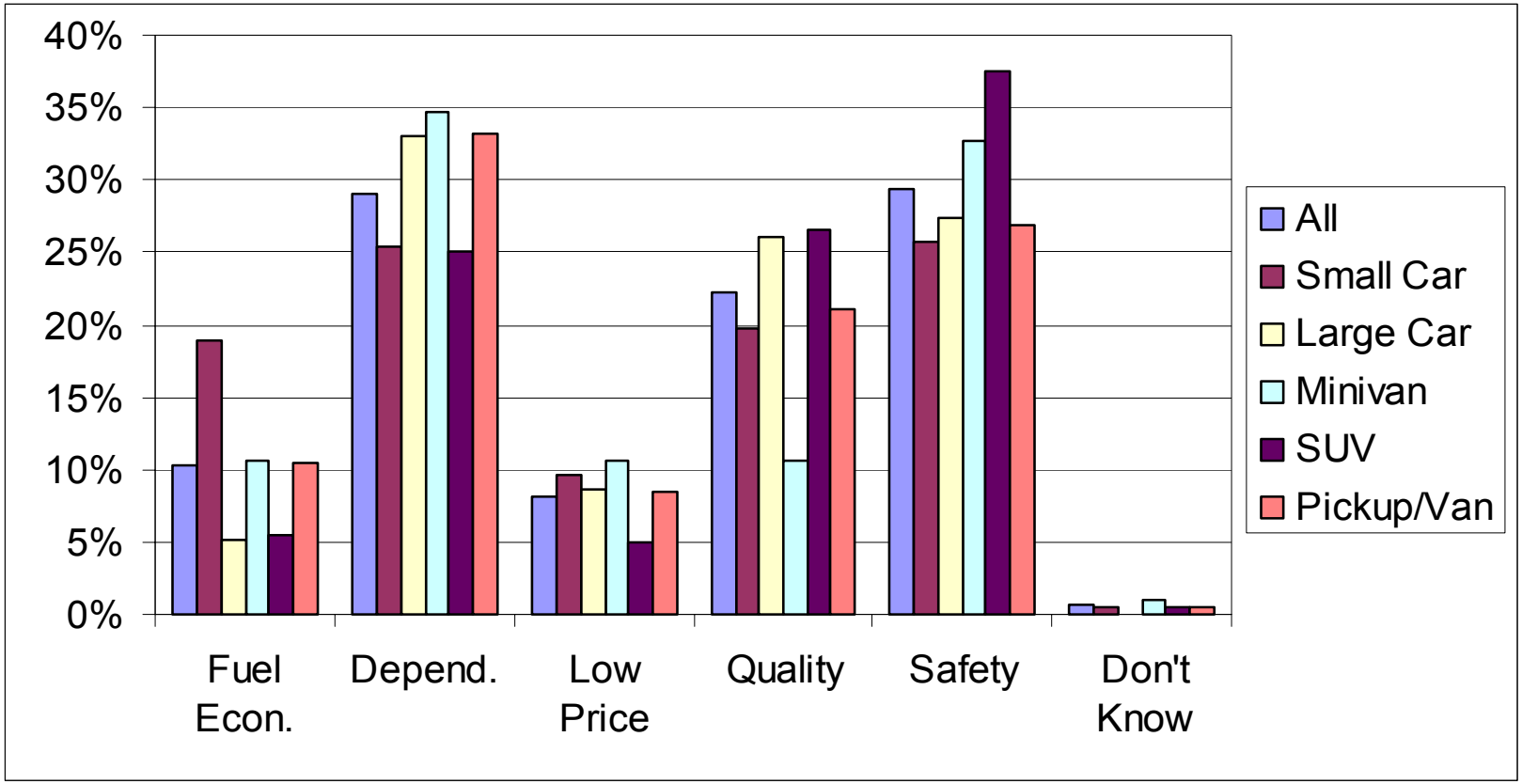
- Require automakers to produce more fuel-efficient cars – **87%**
- Financial incentives for business consumers to conserve energy – **85%**
- Make permitting and building new power plants easier – **69%**
- Place federal price controls on gasoline – **56%**
- Place federal price controls on electricity and natural gas – **54%**
- Place mandatory conservation regulations on business and consumers **– 53%**
- Allow drilling for oil, gas in Alaskan Arctic National Wildlife Refuge **– 43%**
- Relax clean air, environmental standards **– 30%**

Most Important Vehicle Attribute

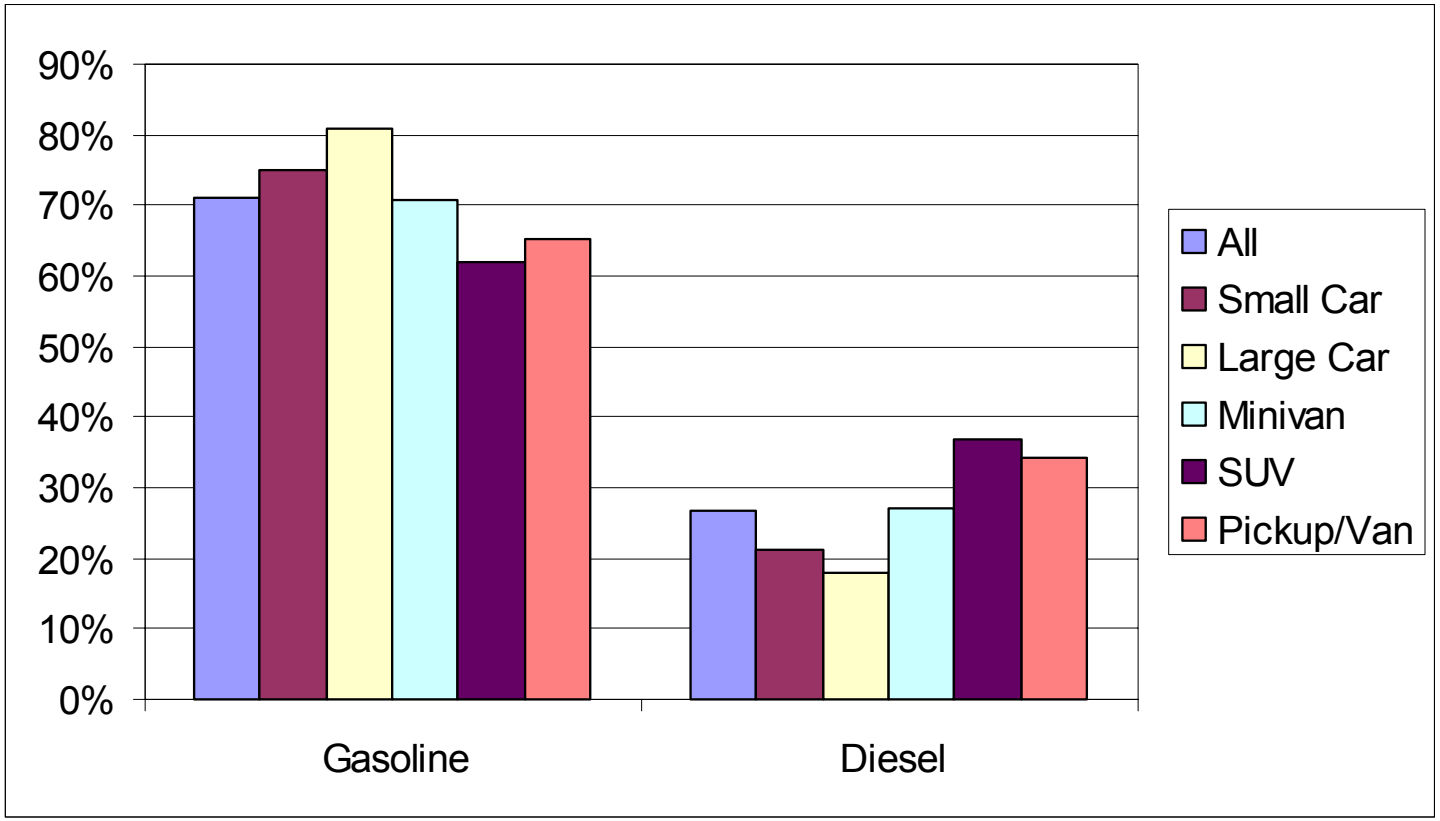
Selected Surveys over the Last 21 Years



Most Important Vehicle Attribute Choice by Vehicle Class



Would buy a diesel engine that gets 40% better MPG and costs $2000 more and is just as clean, dependable, powerful, odorless, and smooth running



Reasons for buying a diesel

- Fuel economy – 46%
- Saves money – 17%
- Diesel fuel is less expensive – 12%
- Dependability – 12%
- Burns cleaner – 7%
- I have a diesel now – 4%
- More power – 3%

Reasons for NOT buying a diesel

- **Too much noise – 19%**
- **Odor – 16%**
- **More pollution – 5%**
- **Cost – 19%**
- **Lack of fuel availability – 17%**
- **Lack of knowledge – 11%**
- **Hard to start in winter – 5%**
- **Don’t like diesels – 7%**

Scenarios to Stabilize Light Vehicle Energy Use by 2010 and 2020

- POW simulations
- Manufacturers just meet CAFE standards
- Reference case: CAFE standard frozen at current levels
- Six scenarios with 3 cases for each 2010 and 2020
  - Case 1: stabilize car and light truck energy use separately
  - Case 2: car and light truck CAFE standards increase by equal percentages
  - Case 3: light truck CAFE standard increases by 75% of the car CAFE increase percentage
- For stabilization by 2010, increases begin in 2004 and ramp in linearly
- For stabilization by 2020, increases need not begin until 2010

Stabilize by 2010 - Case 2

	2000	2010	2020	2030	2040	2050
New Vehicle CAFE, mpg						
Cars	28.13	34.04	37.92	44.87	48.33	54.57
Light Trucks	20.50	25.62	28.54	33.77	36.38	41.08
Light Fleet	24.19	29.24	32.57	38.54	41.51	46.87
Energy Use, Quads						
Cars	8.76	9.48	8.51	8.29	8.27	8.28
Light Trucks	7.06	9.43	10.38	10.62	10.63	10.62
Light Fleet	15.82	18.91	18.89	18.91	18.89	18.90
Energy Saved, Quads						
Annual	0.00	1.34	5.12	8.98	12.56	15.92

Stabilize by 2020 - Case 2

	2000	2010	2020	2030	2040	2050
New Vehicle CAFE, mpg						
Cars	28.13	27.57	34.32	37.89	43.18	46.33
Light Trucks	20.50	20.75	25.83	28.52	32.50	34.87
Light Fleet	24.19	23.68	29.48	32.55	37.09	39.79
Energy Use, Quads						
Cars	8.76	10.04	9.80	9.51	9.52	9.50
Light Trucks	7.06	10.19	11.92	12.21	12.20	12.22
Light Fleet	15.82	20.23	21.72	21.72	21.72	21.72
Energy Saved, Quads						
Annual	0.00	0.01	2.29	6.18	9.74	13.10

Scenario to Save 5 Billion Gallons by 2010

- Proposed House Bill simulated using POW
- Goal: Save 5 billion gallons of gasoline between 2004 and 2010 by increasing CAFE of light trucks
- Reference Case: Manufacturers continue to produce vehicles with MY2000 fuel economies.
  - Light truck energy use grows from 7.0 to 11.7 Quads.
- Scenario: New CAFE is "stepped" in beginning in 2004
- Result: CAFE for light trucks must be increased by 0.56 mpg from 20.7 to 21.26 mpg
  - Savings in 2010: 0.163 Quads
  - Cumulative savings 2004-2010: 0.623 Quads
  - Cumulative savings by 2015 if maintained: 1.77 Quads

OTT WEBSITE TRAFFIC: May 2001

SITE	VISITORS	% CHANGE FROM 2000
OTT	38,326	103%
AFDC	27,833	57%
CLEAN CITIES	7,582	61%
Fuel Economy Guide	**81,591**	**198%**
EREN	260,222	98%